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# Biology of an Endangered Exotic Beetle, *Blaps japonensis* (Coleoptera, Tenebrionidae) in the Laboratory

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**Abstract** *Blaps japonensis* MARSEUL (Coleoptera, Tenebrionidae) is an exotic insect species, which seems to have invaded in Japan since ancient times. Populations of *B. japonensis* have been fragmented and are in danger of extinction. To clarify the ecological requirements of this species, *B. japonensis* was reared in the laboratory. It takes ca. 135 days from egg to adult eclosion under ca. 20°C and relatively dry conditions. *Blaps japonensis* may have a univoltine life cycle in Central Japan, although some adults may survive for more than one year. The larvae feed on rotten grass *Digitaria adscendens* (Poaceae) and solid foods for mouse and insect rearing. The adults feed on fresh leaves of *Sonchus oleaceus* (Asteraceae) and dead wood of *Celtis sinensis* (Ulmaceae) in addition to the commercial foods described above. Among the available foods, solid foods for mouse and insect rearing are the most preferred. The solid foods contain cereals and fish meal. Therefore, cereals and animal proteins under relatively dry conditions may be required for *B. japonensis*. Old barns and stables, the primary habitats of *B. japonensis* in Japan, seem to fulfill the requirements. As is well-known in the Tenebrionidae, pupal gin trap and adult irritant fluid of this species are likely to deter natural enemies.

## Introduction

Diverse insect species have recently been brought to Japan from abroad, and some of these species have established as serious pests of agricultural products, ornamental plants and public hygiene (KIRITANI, 1998). However, only a few exotic species seem to have invaded in Japan during ancient times, and these species now maintain low population densities.

*Blaps japonensis* MARSEUL (Coleoptera, Tenebrionidae) is considered an example,

although there are some criticism. HIURA (1978) pointed out that many *B. japonensis* could be found at old barns of deserted temples surrounded with woodlands and quarry ruins in Osaka, and that this species might therefore have invaded Japan in ancient times. *Blaps japonensis* is distributed in Honshu, Shikoku, Kyushu (central and western Japan), northern China and Taiwan (CHÛJÔ, 1985). However, *B. japonensis* populations have been fragmented and are in danger of extinction in Japan. Despite its exotic origin, several Japanese prefectures such as Shizuoka, Mie and Kyoto list *B. japonensis* as endangered or vulnerable to extinction in their Red Data Books.

The life history of *B. japonensis* is scarcely known, although a matured larva has been described (HAYASHI, 1996). To assist its conservation, the life history and ecological requirements such as the diet and habitat of this species should be known. We successfully reared *B. japonensis* from egg to adult stage in the laboratory. We therefore describe its developmental process, preferred diet and defensive behaviors, and discuss the relationship between the ecological requirements of this beetle and its scarcity.

## Materials and Methods

We collected a female adult *B. japonensis* (21.5 mm in body length) at Iwamuro (34°30′N, 135°32′E, ca. 100 m a.s.l.), Sakai City, Osaka Prefecture in Central Japan on November 1, 2005. All the eggs and larvae used in this study originated this individual. It was housed in a 200-ml plastic cup with crushed rotten *Quercus acutissima* (Fagaceae) wood and solid food for mouse rearing (Oriental Yeast Co., Ltd, MF) in the laboratory. Then it commenced oviposition in the crushed rotten wood from late November.

On December 1, 19 small (<5 mm long) larvae and 39 eggs were placed in two different 200-ml plastic cups. The cups contained crushed rotten *Q. acutissima* wood to a depth of 3 cm. As the larvae grew larger, they were divided into new cups and finally one or two matured larvae were reared per cup. The rearing was carried out in the laboratory under 20±3°C. Dead *Digitaria adscendens* (Poaceae) grass and a mixture of solid foods for mouse (MF) and insect (I) rearing (Oriental Yeast Co., Ltd) were provided as food for the larvae. These solid foods were supplied once a week in a small quantity. Distilled water was sprayed twice a week to prevent extremely desiccated conditions. The cups were checked every 1–3 days, and the developmental period from egg to pupa and pupal period were examined. The egg size (long and short diameters) was determined using an ocular micrometer to the nearest 0.01 mm. The measurement of egg size was taken for newly deposited eggs (within 24 h after oviposition) under relatively dry conditions. The larval length, pupal length (from the fore edge of pronotum to the end of abdomen) and body length of new adults were measured using digital calipers.

Furthermore, the field-collected adult and laboratory-reared new adults (ca. 30 individuals) were provided with fresh leaves of *Sonchus oleaceus* (Asteraceae), *Lamium amplexicaule* (Labiatae) and *Tradescantia fluminensis* (Commelinaceae), dead *Phragmites communis* (Poaceae) reed and dead wood of *Celtis sinensis* (Ulmaceae) in addition

to the commercially available foods described above. The behavior of adults, larvae and pupae were observed during this rearing experiment.

## Results

*From eggs to larvae*

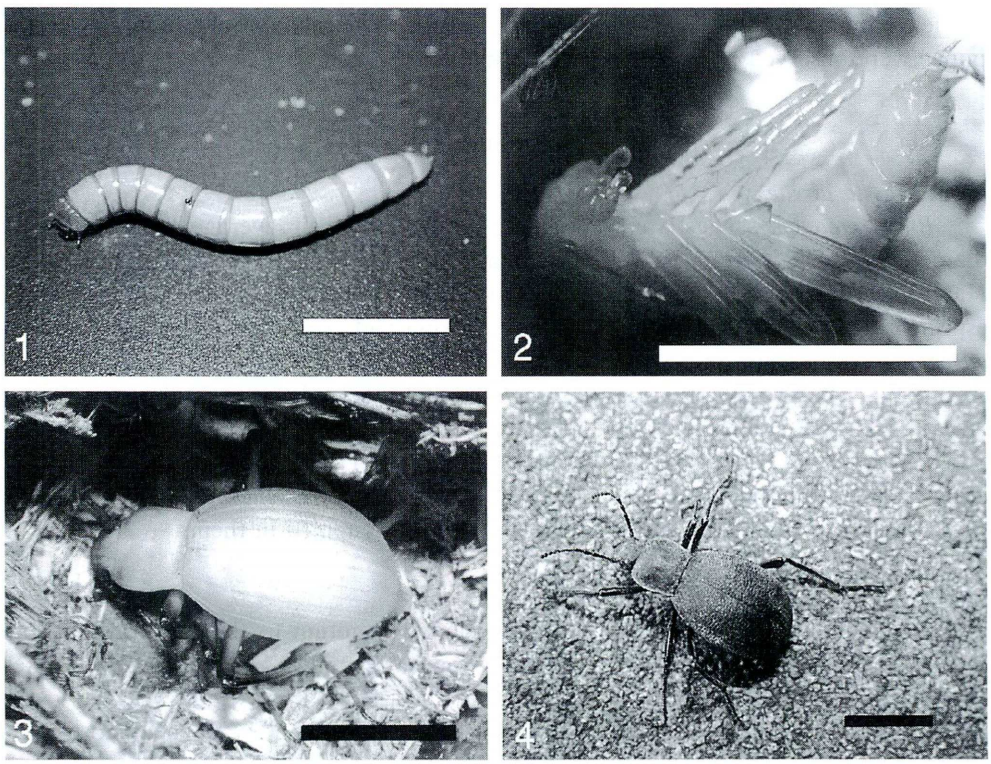
*Blaps japonensis* eggs are oval, matte white, and their average long and short diameters (±S.E.) were 1.97±0.02 mm and 1.13±0.02 mm ($N=18$), respectively. Hatchlings did not feed on egg shells. Larvae fed on dead *D. adscendens* grass and especially solid foods for mouse and insect rearing and grew well. Although dead *D. adscendens* grass and solid foods soon molded, the larvae preferred the molded food to fresh food. The number of instars was unclear. The average length (±S.E.) of matured larvae is 32.11±0.23 mm ($N=10$) (Fig. 1). Average interval (± S.E.) from eggs to pupae was 118.3±2.4 days ($N=24$) in the laboratory. The period was not significantly different between sexes ($t$-test, d.f.=19, $P=0.844$). Matured larvae made pupal cells (ca. 40 mm in diameter) in crushed rotten wood and pupated in them.

*Pupae*

Average pupal length (from the fore edge of pronotum to the end of abdomen) (±S.E.) was 16.30±0.15 mm ($N=30$), and did not significantly differ between sexes ($t$-test, d.f.=27, $P=0.280$). Average pupal period (±S.E.) was 19.0±0.4 days ($N=38$) and was similar between sexes ($t$-test, d.f.=35, $P=0.442$). The pupae, whose color was cream-white, bear serrated projections at both lateral sides of their abdomens (Fig. 2). The pupae usually lie on their backs, and violently shake their abdomens when disturbed. When pupae were reared together with adults or larvae in the same cups, the pupae were often preyed on by adults or larvae. As pupae matured, mandibles, compound eyes, claws, and joints between femora and tibiae become dark-colored.

*Adults*

Adult eclosion took place in the cells both at night and daytime. The new adults are matte white immediately after eclosion (Fig. 3), but after less than two hours they became dark brown (Fig. 4). The sex ratio (female ratio) was 0.55 ($N=38$), and this value was not significantly different from the value 0.5 (Chi-square test, d.f.=1, $\chi^2=0.211$, $P=0.6459$). Average body lengths of new adult males and females are 22.56± 0.24 mm ($N=17$) and 20.81±0.28 ($N=21$), respectively, and these values are significantly different between sexes ($t$-test, d.f.= 36, $P<0.0001$). In addition, this size was comparable to that of the field-collected adult (21.5 mm). Adults preferentially fed on dead *D. adscendens* grass and solid foods similar to larvae, and additionally fresh leaves of *S. oleaceus* and dead wood of *C. sinensis*. However, adults rarely fed on fresh leaves of other herbs and dead reed. When 19 small larvae were reared, 89.5% individuals grew to adults. When 39 eggs were reared, 61.5% hatched and grew to pupae and 53.8% to adults. Matured adults (>10 days after eclosion) raised their abdomens and ejected




Figs. 1–4. Each developmental stage of *Blaps japonensis*. —— 1, Larva; 2, pupa; 3, teneral adult; 4, matured adult. Scale lines: 10 mm.

irritant defensive fluids when disturbed, while teneral adults raised their abdomens but did not eject fluids. The finger skin of the senior author turned brown on exposure to the fluids. Adults commenced oviposition 20–30 days after eclosion.

## Discussion

*Life cycle*

It took ca. 135 days from egg hatching to adult eclosion under ca. 20°C. This period was an underestimation, since the eggs reared were at various ages after oviposition. In addition, it took 20–30 days for new adults to commence oviposition. Therefore, *B. japonensis* may have a univoltine life cycle in Central Japan, although more quantitative data of immature development and temperature measurements in the habitats are required to conclude. Univoltine life cycle is known from two other *Blaps* species in Israel (KAUFMANN, 1953).

*Foods and habitats*

Larvae fed preferentially on solid foods for mouse and insect rearing and grew well, although adults fed on a somewhat wider range of food items. The solid foods were made of cereals and fish meal. Therefore, cereals and animal proteins may be required for larval development. These are not specific foods for soil-inhabiting Tenebrionidae (ALLSOPP, 1980). However, there may be few places in humid, temperate Japan where cereals and animal proteins are abundantly found under relatively dry conditions. Old barns and stables, primary habitats of *B. japonensis* in Japan, seem to fulfill the requirements, because cereals such as rice and rice straw are deposited and the remains of small animals, mice and rats may be present. Several *Blaps* species in the world are known as domiciliary, and inhabit churchyards, wine cellars and stables (MATTHEWS, 1975). Since the elytra of *B. japonensis* are mid-dorsally fused and their hind wings are degenerated, this species is flightless. Thus, the existence of old barns and stables as well as transportation of stored products and straw may be required to maintain meta-populations of *B. japonensis.* Scarcity of this beetle may be attributable to the loss of old barns and stables and the rare movements of stored products and straw among the remaining facilities.

*Defensive devices*

Pupae had lateral serrated projections on their abdomens and violently shook the abdomens when disturbed. This pupal structure coupled with its behavior would function as a 'gin trap,' which is defined as sclerotized projections that are closed with great speed and power to damage potential predators and parasites (HINTON, 1946; BOUCHARD & STEINER JR., 2004). This gin trap may prevent parasitism by mites or predation by predaceous fly larvae, although it could not prevent cannibalism by conspecific adults or larvae.

Matured adults of *B. japonensis* ejected fluids when disturbed. *Blaps mucronata* (LATREILLE) in Italy ejects fluids containing two quinones to deter ants (PESCHKE & EISNER, 1987). The fluid of *B. japonensis* may also play a defensive role.

## 要　　約

山崎一夫・杉浦真治：室内飼育で確認されたヤマトオサムシダマシの生活史．—— ヤマトオサムシダマシは，古代に日本に侵入したと考えられる外来昆虫である．本種の個体群は分断化され，国内では絶滅に瀕している．本種の生態的要求を解明するために，室内飼育を行った．卵から羽化まで約 20°C のやや乾燥した条件で，約 135 日を要した．おそらく年 1 化の生活環をもっているのだろう．幼虫は，枯れたメヒシバや，マウスと昆虫類の固形飼料を摂食して発育した．成虫は，これらに加え，ノゲシの生葉，エノキの枯木も摂食した．固形飼料は幼虫および成虫ともにもっとも好んだ食物であり，穀類と魚粉を主原料とするので，穀類と動物性タンパク質が比較的乾燥した状態で存在することが本種に必要なのかもしれない．本種のおもな生息環境である古い納屋や厩舎は，そうした条件を満たすように思われる．蛹の腹部側面には歯状の突起があり，

'gin trap' として，寄生者および捕食者に対する防御の機能をもっているものと思われる．成虫は腹端から防御物質を噴出した．

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